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To: Mark IV Development Group

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Subject: Serial Link Cables

Sergei Pogrebenko has checked the SUIM-to-Input Board serial link connection with different cable lengths, using 5 mm-diameter double-shielded cable at 960 MBaud.

The results are:

1. Without on-chip equalization (p8 = OFF)

- 1.1. 9 m cable = OK
- 1.2. 15m cable = OK
- 1.3. 25m cable = does not work
- 1.4. 30m cable = does not work

2. With on-chip equalization (p8 = ON)

- 2.1. 9 m = OK
- 2.2. 15m = OK
- 2.3. 25m = OK
- 2.4. 30m = marginal. It keeps lock for 15-20 minutes only.

Fortunately, we will have 15m maximum length with the Data Distributor and 25m maximum length without the DD.

From the error rate vs. cable length plot for the G-Link Transmit/Receive Chip Set from Hewlett Packard, shown in the attached figure, it looks like 22 meters of RG-58 should be OK at the maximum data rate of 1.2 GBaud, which corresponds to a multiplexed link operating at a parallel word rate of 40 Mwords/sec. Maximum cable length depends on data rate, and on cable type. All cables have increased length-dependent loss at higher frequencies, with more loss for smaller cables, as shown in the attached table of loss characteristics for common types of coaxial cables. (The same considerations apply to ethernet cables.) If you have problems with long cables, you can switch to a **50-ohm** cable with lower loss at 1 GHz, such as FM-58 or FM-8, which have foam dielectrics. (Cables larger than 5-mm are necessary for the IF signals from the receiver on the antenna to the IF distributor in the control room.)

Also, the transformer contributes to high-frequency loss and phase shift, so I would expect links with

transformers to be more sensitive to long cable runs than links without transformers.

Do not forget that these links are running at a frequency near 1000 MHz, and are therefore similar to IF cables.

Please note that the results reported above are for 960 Mbaud. The JIVE Correlator is multiplexing 25 signals on one 16-channel link, causing the link to run at  $20 \times 48 = 960$  Mbaud. (There are 4 overhead bits.) The Mark IV Correlator is using the links at only  $20 \times 32 = 640$  Mbaud, because the dual links used in the Mark IV Correlator require no multiplexing. So the Mark IV Correlator can tolerate longer cables than JIVE.

The following paragraphs contain my cable recommendations for a Mark IV Correlator, using conservative estimates based on the above data.

For the serial links in a Mark IV Correlator, use RG316 for short cable runs (less than 12 meters total between Tx and Rx. To get the total length of the run, you need to add the cable length between the Tx and the splitter box to length between the splitter box and the Rx). Longer lengths of RG316 might be OK, but would require some testing.

Use RG223/U (not RG55) for long cables (up to 25 meters total). (RG223 is 50 ohms, but RG55 is 53.5 ohms.) Longer lengths of RG223 might be OK, but would require some testing.